

# Collaborative and Competitive Futures for Virtual Reality Music and Sound

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Figure 1: Four performers playing the Coretet virtual string instruments in a networked session.

## ABSTRACT

The histories of virtual reality systems draw heavily from foundational work in telepresence and robotics, cinema and gaming. Across each of these disciplines the roles of "player" and "audience" member vary significantly, as do the rules, affordances and experiential goals put forth by the systems themselves. As such, designers and developers of interactive virtual (here defined as including mixed and augmented) reality systems are faced with a fundamental choice: to create experiences that are inherently collaborative or competitive. While on the surface such a choice might seem a simple articulation of the core design principles for any one given project, the directions in which virtual reality systems are guided and the impacts these choices will have on societal acceptance of VR as a principal component of our technological futures should not be ignored. This paper discusses models of collaboration and competition as put forth within a series of interactive virtual experiences and proposes an ideal future for virtual reality in which interactivity and telepresence leverage collaboration as a core mechanic.

**Index Terms:** J.5 [Computer Applications]: Arts and Humanities—fine arts H.5.5 [Sound and Music Computing] H.5.1 [Information Interfaces and presentation]: Multimedia Information Systems—Artificial, augmented, and virtual realities

## 1 INTRODUCTION

Much existing discussion around virtual reality systems focuses on technological advances ranging from higher pixel density for head-mounted displays (HMD) to the simulation of real-world environments in real-time, to the procedural generation of dynamic audio environments. And while the scale of such technological achievements coupled with the staggering speed of engineering progress is impressive, the fundamental social and experiential concerns as to how virtual reality systems will be incorporated into our societies as a greater whole are often given relatively short shrift. The major commercial concerns invested in virtual reality systems - including Facebook/Oculus<sup>1</sup>, Valve/HTC<sup>2</sup>, Microsoft<sup>3</sup>, Google<sup>4</sup> and Magic Leap<sup>5</sup> - each seek that killer app that will bring VR systems the ubiquitous consumer adoption that we saw in mobile software with the introduction of the smartphone and its companion app store.

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<sup>1</sup><https://www.oculus.com/>

<sup>2</sup><https://www.vive.com/us/>

<sup>3</sup><https://www.microsoft.com/en-us/hololens>

<sup>4</sup><https://vr.google.com/>

<sup>5</sup><https://www.magicleap.com/>

Following that model, we see in gaming and cinema the kinds of commercial opportunities that can funnel consumers towards VR. But while cinema generates huge revenues with widespread adoption worldwide, the medium inherently lacks interactivity and has historically been designed for passive consumption. For the most part, attempts at designing VR cinematic experiences have fallen victim to their own *raison d'être*. Film has always provided artists an opportunity to present a specialized view to an audience, leveraging specific cinematographies, narrative arcs and deliberate paces to craft a series of precise views into an artistic vision. The flexible nature of VR disrupts this model by granting control to audiences over where and when they are looking. The filmmaker's historical role of dictator/savant in absolute control over what, when and how presentations are made to the audience simply can not co-exist within virtual reality without undergoing significant change.

On the other hand, gaming is a multi-billion dollar industry fundamentally designed around user interaction, variable user-determined visual foci and nonlinear timescales. Video games have steadily evolved from a simplistic interaction model and presentation from the DEC PDP-1-driven space-combat simulation *Spacewar!*<sup>6</sup> to the rich graphical content and networked social experiences of a game like Epic Games' *Fortnite*<sup>7</sup>. The use of three-dimensional graphics - albeit on a two-dimensional screen - has long been commonplace in games, increasing our sense of immersion and presence in a game's virtual space even without the use of specific virtual reality hardware or software systems. In short, gaming's nature as an interactive and nonlinear art form makes it a perfect model for virtual reality.

## 2 COMPETITION AND GAMING

One common characteristic of games is an inherent reliance on competition as a core mechanic. A completed game experience generally means one or more winners have defeated one or more losers. Ideally each player of a given game experiences a net positive reaction to the experience: sufficient enjoyment was created during the playing of the game to offset the negative connotations generated through a loss. However we see many cases, especially when playing games with children, where the negative aspects of competition overwhelm the positive, creating clear social issues. As computer games have increasingly become networked social competitive experiences, gaming communities across the internet have been forced to deal with toxic language and behaviors between participants. Competition does not always bring out the best in us. One need only join a competitive game of *Overwatch*<sup>8</sup> or *Starcraft II*<sup>9</sup> to understand the negative impact that competition paired with anonymity can bring out in our societies.

## 3 ARTISTIC MODELS OF COLLABORATION

Another potential model that could be applied to virtual reality experiences can be found through artistic collaboration, here defined to include active and participatory art forms such as dance, and music. Participants in ensemble musical performances or members of a dance troupe serve as integral parts of a whole. At both the micro (a dancer's arc of the back) and the macro (an ensemble crescendo) levels, individual action and expression are necessary for the entire experience to succeed. In this model, a focus on collaboration does not remove the possibility of failure and the inherent negative connotations contained therein. However success is attained through coordination and mutual support, rather than through direct competition. The positive aspects of Play are reinforced and the negative are diminished, creating an overwhelmingly supportive

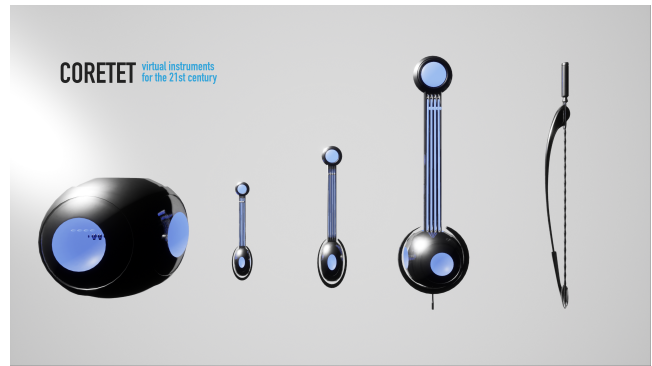


Figure 2: Configurations of the Coretet virtual instrument from left to right: orb, violin, viola, cello and the bow.

environment for virtual versions of ourselves to interact with our networked peers. This section describes three collaborative game-based virtual environments designed as collaborative experiences.

### 3.1 Coretet

Coretet is a virtual reality musical instrument and networked performance environment designed to model the performative and interaction schema from a traditional string quartet [2]. Players of Coretet can enter a shared virtual space wherein each player's avatar and musical instrument can be seen and heard. When presented to a real-world audience, a view into the live Coretet environment is projected onto a large two-dimensional display and multi-channel audio systems are used to spatialize the sound of each performer's instrument around the room.

Coretet as a project leverages gaming technologies such as the Unreal Engine 4<sup>10</sup>, the Oculus Rift HMD and Oculus Touch controllers. The look and feel of Coretet is clearly descended from video games (all models used to build Coretet are part of a model-kit designed by artist Chris Platz for the musical performance work *Carillon*). In order to run Coretet, a hardware footprint of one server desktop running an NVIDIA TitanX 16 Gb video card, four gaming laptops with NVIDIA 1070 video cards, and an audio server and multi-channel soundcard are required. Initial design and development of Coretet was sponsored by the GAPPP project [4] and the first piece composed for Coretet - *Trois Machines de la Grce Aimante* - was premiered by trained string musicians in concert at the IEM in Graz, Austria in September, 2018. As such, on the surface, Coretet has more in common with a networked LAN gaming party where virtual combatants might compete playing *Quake III*<sup>11</sup> than with a chamber ensemble reading through a Mozart quartet.

### 3.2 Carillon

*Carillon*, for three virtual reality performers, was designed as a virtual analogue to multi-user traditional musical instruments, such as a 4-hands piano [3]. Players in *Carillon* stand facing one another atop a floating machine, designed as a futuristic bell-tower. While the tower is surrounded by traditional bell-shaped instruments, the fundamental user interaction of *Carillon* lies within a set of interlocking rings in the center of the structure. Each player controls a full-bodied avatar, with their physical hands directly mapped onto the hands of their corresponding avatar using Leap Motion hand tracking controllers. The core interaction of *Carillon* allows each performer to take control over one or more rings and set them into motion. The rotation direction, speed and translation of each ring

<sup>6</sup><https://www.computerhistory.org/pdp-1/spacewar/>

<sup>7</sup><https://www.epicgames.com/fortnite/en-US/home>

<sup>8</sup><https://playoverwatch.com/en-us/>

<sup>9</sup><https://starcraft2.com/en-us/>

<sup>10</sup><https://www.unrealengine.com>

<sup>11</sup><https://ioquake3.org/>



Figure 3: Two performers controlling *Carillon's* musical rings.

procedurally generates pitched musical material, turning the set of rings into a performable musical instrument.

*Carillon* was designed to be by necessity a collaborative musical performance. At any moment, more than one performer might select and attempt to set into motion the same ring. If this were to happen, performers would come into conflict with one another resulting in a situation where no one performer can prevail. The system breaks down if multiple control signals are sent to a given ring at the same time, preventing the machine from operating smoothly as intended. The only way for performers to achieve a robust and musically-articulate performance is to develop cooperative strategies to prevent direct competition for individual rings. No one performer can create a successful performance without consciously attending to the gesture and sonic output of the other two performers.

### 3.3 *Nous Sommes Tous Fernando...*

Leveraging technologies initially designed for competitive gaming concerns into collaborative and artistic systems can expose fundamental design implications of specific technologies that stress conflict and competition over collaboration. In a game-based performance work entitled *Nous Sommes Tous Fernando* an interactive musical environment was created by hacking the Quake III gaming engine to generate musical tones when previously lethal virtual weapon projectiles collided with the walls, floors and ceilings of the virtual environment [1].

The composition was intended to be completely collaborative with no possible competitive direction made available to performers. However, in an early iteration of the system, a series of cheat key commands used in the original game to give players weapons and ammunition had been left active (though not exposed) in the engine itself. During initial rehearsals with performers from the Stanford Laptop Orchestra [6], knowledge of these key commands quickly spread throughout the ensemble, turning the collaborative and performative musical rehearsal into a strikingly competitive and aggressive bout of virtual combat. And while the work was created as a artistic example of the adage turning swords into plowshares or repurposing weapons into artifacts of peace, the very nature of the game-like experience made performers feel comfortable deviating from the express musical intent of the piece, appropriating virtually violent behaviors that were fundamentally at odds with the artistic intent of the performance itself.

## 4 DISCUSSION

As more and more of our virtual selves move onto an increasingly socially-focused internet, our ability to access communities of compatible (if not like-minded) individuals has become a fundamental component of gaming or virtual reality experiences. The software



Figure 4: Performers in *Nous Sommes Tous Fernando...* repurpose virtual weapons into instruments of musical sound.

environments and products through which we engage these networked communities fundamentally color our social interactions with other human users of virtual systems. In a day and age when many people's principal communication medium is the internet, it no longer feels extreme to say that the societal impact of the platforms within which we host these communications will have significant impact on the manner in which our society functions as a whole. And when considering the direction in which core game mechanics are applied to game and game-like software projects, it is important to recognize the potential for bias in the very tools artists and designers use to craft their work. The history of the Unreal Engine - the development platform and engine used in both *Carillon* and *Coretet* - shows the engine's own internal bias towards first-person shooter and combat simulation projects [5]. From demonstration examples showing avatars with weapons to the "trigger" buttons on the Oculus Touch controller, a view of virtual space as a potential battleground is constantly being reinforced to designers and developers alike.

## 5 CONCLUSIONS

This paper has presented three virtual interactive environments where game mechanics and musical ensemble cooperation are combined to create inherently collaborative virtual spaces. In each of these works, networked three-dimensional virtual reality systems leverage existing gaming technologies and frameworks to create collaborative interactive spaces within which participants must cooperate to achieve a desired result. Building on collaborative models such as those found across arts practices, the future of VR applications can embrace a direction focused on community building and social cooperation rather than one focused on inherent competition.

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## REFERENCES

- [1] R. Hamilton. q3osc: Or How I Learned To Stop Worrying And Love The Game. In *Proceedings of the International Computer Music Conference*. Belfast, Ireland, August 2008.
- [2] R. Hamilton. Coretet: A 21st Century Virtual Reality Musical Instrument for solo and ensemble performance. In *Proceedings of the IEEE VR International Conference*. Osaka, Japan, March 2019.
- [3] R. Hamilton and C. Platz. Gesture-based Collaborative Virtual Reality Performance in Carillon. In *Proceedings of the International Computer Music Conference*. Utrecht, Netherlands, September 2008.
- [4] B. Lüneburg. Between Art and Game: Performance Practice in the Gamified Audiovisual Artworks of GAPPP. *The Computer Games Journal*, 7(4):243–260, Dec 2018.
- [5] J. Malazita. The Material Undermining of Magical Feminism in BioShock Infinite: Burial at Sea. pp. 37–50. Palgrave Macmillan, 2018.
- [6] G. Wang, N. Bryan, J. Oh, and R. Hamilton. Stanford Laptop Orchestra (SLORK). In *Proceedings of the International Computer Music Association Conference*. Montreal, Canada, 2009.